

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1 1. A method of MIG welding comprising:
2 providing ac power to a weld, wherein the ac
3 power has a negative portion and a positive portion,
4 and the ac power further has a frequency;
5 wherein the negative portion is greater than
6 the positive portion;
7 wherein the frequency is at least 60 Hz.

1 2. The method of claim 1, wherein the frequency
2 is between 90 Hz and 120 Hz.

1 3. The method of claim 1, further including
2 providing a consumable, flux-cored, wire to the weld.

1 4. The method of claim 1, further including
2 providing a consumable, metal-cored, wire to the weld.

1 5. The method of Claim 4, wherein providing the
2 wire includes providing a wire wherein the wire comprises a
3 sheath encapsulating a core having a core composition, the
4 core composition comprising a combination of graphite and
5 one or more compounds of potassium, the combination of
6 graphite and compounds of potassium in the core composition
7 not exceeding approximately 5% by weight.

1 6. The method of Claim 5, wherein providing the
2 wire includes providing the wire electrode wherein the one
3 or more compounds of potassium comprise K_2MnTiO_4 .

1 7. The method of Claim 6, wherein providing the
2 includes providing the wire wherein the combination is
3 selected from the range from about 0.3% to about 5.0% by
4 weight.

1 8. The method of claim 1, further comprising
2 providing a weld path on at least one workpiece, wherein the
3 weld path includes a groove having an angle of less than 50
4 degrees.

1 9. The method of claim 1, further comprising
2 providing a weld path on at least one workpiece, wherein the
3 weld path includes a groove having an angle of less than 30
4 degrees.

1 10. The method of claim 1, further comprising
2 providing a weld path on at least one workpiece, wherein the
3 weld path includes a groove having an angle of between 20
4 degrees and 30 degrees.

1 11. The method of claim 1, including welding at a
2 rate of at least 35 pounds per hour using a single arc.

1 12. The method of claim 11 including welding at a
2 rate of at least 40 pounds per hour.

1 13. The method of claim 11 wherein the negative
2 portion is at least twice the positive portion.

1 14. The method of claim 10 wherein the negative
2 portion is at least 1.5 times the positive portion.

1 15. The method of claim 1 wherein the weld
2 process begins with a first negative portion having a
3 duration of at least 0.5 seconds.

1 16. The method of claim 14 wherein the weld
2 process begins with a first negative portion having a
3 duration of at least 0.75 seconds.

1 17. The method of claim 1 further including
2 providing a stick-out of about 2 inches.

1 18. The method of claim 17 further comprising
2 providing a shielding gas at a rate of at least 80 cubic
3 feet per hour.

1 19. A method of MIG welding comprising:
2 providing ac power to a weld, wherein the ac
3 power has a negative portion and a positive portion,
4 and the ac power further has a frequency; and
5 providing at least one workpiece with a weld
6 path thereon, wherein the weld path includes a groove
7 having an angle of less than 50 degrees.

1 20. The method of claim 19, wherein providing at
2 least one workpiece includes providing the weld path with
3 the groove having the angle between 20 degrees and 30
4 degrees.

1 21. The method of claim 19, wherein providing at
2 least one workpiece includes providing the weld path with
3 the groove having the angle less than 30 degrees.

1 22. The method of Claim 21, further comprising
2 providing a wire comprising a sheath encapsulating a core

3 having a core composition, the core composition comprising a
4 combination of graphite and one or more compounds of
5 potassium, the combination of graphite and compounds of
6 potassium in the core composition not exceeding
7 approximately 5% by weight.

1 23. The method of Claim 22, wherein providing the
2 wire includes providing the wire electrode wherein the one
3 or more compounds of potassium comprise K_2MnTiO_4 , and the
4 combination is selected from the range from about 0.3% to
5 about 5.0% by weight.

1 24. The method of claim 21 wherein:
2 the negative portion is greater than the positive
3 portion; and
4 the negative portion is at least 1.5 times the
5 positive portion.

1 25. The method of claim 24, wherein the frequency
2 is between 90 Hz and 120 Hz.

1 26. The method of claim 24, further including
2 providing a consumable, metal-cored, wire to the weld.

1 27. The method of Claim 24, further comprising
2 providing a wire comprising a sheath encapsulating a core
3 having a core composition, the core composition comprising a
4 combination of graphite and one or more compounds of
5 potassium, the combination of graphite and compounds of
6 potassium in the core composition not exceeding
7 approximately 5% by weight.

1 28. The method of Claim 27, wherein providing the
2 wire includes providing the wire electrode wherein the one

3 or more compounds of potassium comprise K_2MnTiO_4 , and the
4 combination is selected from the range from about 0.3% to
5 about 5.0% by weight.

1 29. A method of MIG welding comprising:
2 providing ac power to a weld having a
3 negative portion and a positive portion, and the ac
4 power further having a frequency; and
5 providing a consumable, cored, wire to the
6 weld.

1 30. The method of claim 29 wherein the weld
2 process begins with a first negative portion having a
3 duration of at least 0.5 seconds.

1 31. The method of claim 29 wherein the weld
2 process begins with a first negative portion having a
3 duration of at least 0.75 seconds.

1 32. A method of MIG welding comprising:
2 providing ac power to a weld, wherein the ac
3 power has a negative portion and a positive portion,
4 and the ac power further has a frequency; and
5 providing a consumable wire to the weld at a
6 rate of at least 35 pounds per hour using a single arc.

1 33. The method of Claim 32, wherein providing the
2 wire further comprises providing a wire comprising a sheath
3 encapsulating a core having a core composition, the core
4 composition comprising a combination of graphite and one or
5 more compounds of potassium, the combination of graphite and
6 compounds of potassium in the core composition not exceeding
7 approximately 5% by weight.

1 34. The method of Claim 33, wherein providing the
2 wire includes providing the wire electrode wherein the one
3 or more compounds of potassium comprise K_2MnTiO_4 , and the
4 combination is selected from the range from about 0.3% to
5 about 5.0% by weight.

1 35. The method of claim 32, including providing a
2 consumable to the weld at a rate of at least 40 pounds per
3 hour.

1 36. The method of claim 35, further comprising
2 providing the weld path on at least one work piece, wherein
3 the weld path includes a groove having an angle of less than
4 30 degrees.

1 37. The method of claim 32 wherein the negative
2 portion is at least twice the positive portion.

1 38. The method of claim 37 wherein the duration
2 of the negative portion is at least 1.5 times the duration
3 of the positive portion.

1 39. A method of MIG welding comprising:
2 providing ac power to a weld having a
3 negative portion and a positive portion, and the ac
4 power further having a frequency; and
5 wherein the negative portion is at least 1.5
6 times the positive portion.

1 40. The method of claim 39 wherein the duration
2 of the negative portion is at least 1.5 times the duration
3 of the positive portion.

1 41. The method of claim 39 wherein the weld
2 process begins with a first negative portion having a
3 duration of at least 0.5 seconds.

1 42. The method of claim 39 wherein the weld
2 process begins with a first negative portion having a
3 duration of at least 0.75 seconds.

1 43. A method of MIG welding comprising:
2 providing ac power to a weld, wherein the ac
3 power has a negative portion and a positive portion,
4 and the ac power further has a frequency;
5 wherein the negative portion is greater than
6 the positive portion; and
7 wherein the weld process begins with the
8 negative portion of at least 0.5 seconds duration.

1 44. The method of claim 43 wherein the weld
2 process begins with a first negative portion having a
3 duration of at least 0.75 seconds.

1 45. An apparatus for MIG welding a substrate
2 of low carbon steel having a thickness of at least 1/2
3 inch comprising:
4 a table for holding the substrate;
5 a MIG gun;
6 a carriage for traversing the MIG gun over
7 the substrate and providing a deposition rate of at
8 least 30 pounds per hour;
9 a source of shielding gas disposed to provide
10 the shielding gas to the MIG gun; and
11 a power source, connected to the MIG gun,
12 capable of providing a substantially square AC current

13 at the MIG gun, with the average current being at least
14 300 amps.

1 46. A method of MIG welding comprising:
2 providing ac power to a weld, wherein the ac
3 power has a negative portion and a positive portion,
4 and the ac power further has a frequency;
5 wherein the negative portion has a negative
6 amp-seconds and the positive portion has a positive
7 amp-seconds, and further wherein the magnitude of the
8 negative amp-seconds is greater than the magnitude of
9 the positive amp-seconds; and
10 wherein the frequency is at least 60 Hz.

1 47. The method of Claim 46, further comprising
2 providing a wire comprising a sheath encapsulating a core
3 having a core composition, the core composition comprising a
4 combination of graphite and one or more compounds of
5 potassium, the combination of graphite and compounds of
6 potassium in the core composition not exceeding
7 approximately 5% by weight.

1 48. The method of Claim 47, wherein providing the
2 wire includes providing the wire electrode wherein the one
3 or more compounds of potassium comprise K_2MnTiO_4 , and the
4 combination is selected from the range from about 0.3% to
5 about 5.0% by weight.

1 49. A MIG welding system comprising:
2 power means for providing ac power to a weld,
3 wherein the ac power has a negative portion and a
4 positive portion, and the ac power further has a
5 frequency; and

6 control means for controlling the power
7 means, wherein the negative portion has a negative amp-
8 seconds and the positive portion has a positive amp-
9 seconds, wherein the control means causes the negative
10 amp-seconds to be greater than the positive amp-
11 seconds, and wherein the frequency is at least 60 Hz.

1 50. The system of claim 49, wherein the control
2 means includes means for providing the frequency to be
3 between 90 Hz and 120 Hz.

1 51. The system of claim 49, further including a
2 consumable, flux-cored, wire, disposed to be provided to the
3 weld.

1 52. The system of claim 51, wherein the wire is
2 metal-cored.

1 53. The system of claim 52, further comprising a
2 weld path on at least one work piece, wherein the weld path
3 includes a groove having an angle of less than 50 degrees.

1 54. The system of claim 49, further comprising a
2 weld path on at least one workpiece, wherein the weld path
3 includes a groove having an angle of less than 30 degrees.

1 55. The system of claim 54 wherein the control
2 means for includes means for causing the negative amp-
3 seconds to be at least twice the positive amp-seconds.

1 56. The system of claim 49 wherein the control
2 means includes means for causing the negative amp-seconds to
3 be at least 1.5 times the positive amp-seconds.

1 57. The system of claim 56 wherein the control
2 means includes means for causing the weld process to begin
3 with a first negative portion having a duration of at least
4 0.5 seconds.

1 58. The system of claim 49 wherein the control
2 means includes means for causing the weld process to begin
3 with a first cycle portion having a duration of at least
4 0.75 seconds.

1 59. A system of MIG welding arc comprising:
2 power means for providing to a weld ac power
3 having a negative portion and a positive portion, and
4 the ac power further having a frequency; and
5 means for providing a consumable, cored, wire
6 to the weld.

1 60. The system of claim 59 wherein the power
2 means includes means for beginning the weld process with a
3 first negative portion having a duration of at least 0.5
4 seconds.

1 61. A system of MIG welding comprising:
2 power means for providing ac power to a weld,
3 the ac power having a negative portion and a positive
4 portion, and the ac power further having a frequency;
5 and
6 means for controlling the power means such
7 that the negative portion is at least 1.5 times the
8 positive portion.

9 62. The system of claim 59 further comprising
10 means for controlling the power means such that the weld

11 process begins with a first negative portion having a
12 duration of at least 0.5 seconds.

1 63. A system of MIG welding comprising:
2 power means for providing ac power to a weld,
3 wherein the ac power has a negative portion and a
4 positive portion, and further has a frequency;
5 control means for controlling the power means
6 such that the negative portion is greater than the
7 positive portion, and further such that the weld
8 process begins with the negative portion for at least
9 0.5 seconds.

1 64. A system of MIG welding comprising:
2 power means for providing ac power to a weld,
3 wherein the ac power has a negative portion and a
4 positive portion, and further has a frequency;
5 control means for controlling the power means
6 such that the negative portion has a negative amp-
7 seconds and the positive portion has a positive amp-
8 seconds, and further wherein the magnitude of the
9 negative amp-seconds is greater than the magnitude of
10 the positive amp-seconds.

1 65. A system of MIG welding comprising:
2 an ac power source having a MIG output with a
3 positive portion and a negative portion;
4 a controller controllably connected to the
5 power source;
6 a feedback circuit disposed electrically
7 between the power source and the controller;
8 a source of consumable wire, disposed to
9 provide wire to the MIG output;

10 wherein the controller provides that the
11 negative portion is greater than the positive portion,
12 and further wherein the MIG output has a frequency of
13 at least 60 Hz.

1 66. The system of claim 65, wherein the power
2 source is a step-up cycloconverter and the frequency is
3 between 90 Hz and 120 Hz.

1 67. The system of claim 65, wherein the wire is a
2 flux-cored wire.

1 68. The system of claim 65, wherein the wire
2 comprises a sheath encapsulating a core having a core
3 composition, the core composition comprising a combination
4 of graphite and one or more compounds of potassium, the
5 combination of graphite and compounds of potassium in the
6 core composition not exceeding approximately 5% by weight.

1 69. The system of Claim 68, the one or more
2 compounds of potassium comprise K_2MnTiO_4 .

1 70. The system of Claim 69, wherein the
2 combination is selected from the range from about 0.3% to
3 about 5.0% by weight.

1 71. The system of claim 67, further comprising
2 providing a weld path on at least one work piece, wherein
3 the weld path includes a groove having an angle of less than
4 50 degrees.

1 72. The system of claim 67, further comprising
2 providing a weld path on at least one work piece, wherein

3 the weld path includes a groove having an angle of less than
4 30 degrees.

1 73. The system of claim 67 wherein the negative
2 portion is at least 1.5 times the positive portion.

1 74. The system of claim 67 wherein the controller
2 includes a start circuit, a control output and a timing
3 circuit, that provides a negative portion having a duration
4 of at least 0.5 seconds at the start of the weld process.

1 75. A system of MIG welding comprising:
2 a MIG torch;
3 an ac power source disposed to provide ac
4 power to the MIG torch;
5 a source of consumable wire, disposed to
6 provide wire to the MIG torch; and
7 wherein the wire comprises a sheath
8 encapsulating a core having a core composition, the
9 core composition comprising a combination of graphite
10 and one or more compounds of potassium, the combination
11 of graphite and compounds of potassium in the core
12 composition not exceeding approximately 5% by weight.

1 76. The system of Claim 75, the one or more
2 compounds of potassium comprise K_2MnTiO_4 .

1 77. The system of Claim 76, wherein the
2 combination is selected from the range from about 0.3% to
3 about 5.0% by weight.

1 78. The system of claim 75 further comprising a
2 controller operatively connected to the power source, and
3 including a start circuit having a time delay and a control

4 output, wherein the weld process begins with a first
5 negative portion having a duration of at least 0.5 seconds.

1 79. A system of MIG welding comprising:
2 an ac power source having a control input and
3 a MIG output, wherein the MIG output has a negative
4 portion and a positive portion;
5 a controller, including a balance circuit and
6 a feedback circuit, operatively connected to the
7 control input such that the negative portion is at
8 least 1.5 times the positive portion.

9 80. A method of controlling dilution in MIG
10 welding comprising:
11 providing ac power to a weld, wherein the ac
12 power has a negative portion and a positive portion,
13 and the ac power further has a frequency;
14 controlling the balance of the negative
15 portion and the positive portion to obtain a desired
16 dilution.

1 81. The method of claim 80 wherein the negative
2 portion is greater than the positive portion.

1 82. The method of claim 80 wherein the negative
2 portion is less than the positive portion.